General Physics

PHYSICS OF POTASSIUM ION CHANNEL INACTIVATION IN NEURONS

Ryan M. W. Collins, Clif C. Chancey*

Department of Physics
University of Northern Iowa
Cedar Falls, IA 50614-0150
physics@uni.edu

Abstract

The electrical signaling capabilities of neurons depend on the flows of ions into and out of the cells, particularly their axons. Potassium ions exit an axon's interior through a potassium channel or pore that connects the intracellular region with the extracellular region. The channel opens, or is activated, allowing potassium ions to exit. The channel then undergoes a blocking transition in which the channel is physically open but is blocked by some part or parts of the larger channel molecular. This blocking process is called inactivation, and the physics by which it might occur forms the topic of our investigation. The N-terminus region of the Drosopila shaker potassium ion channel was identified by Hoshi et al as having an important role in channel inactivation. Using the last 19 amino acids in the N-terminus region, a mass and net charge were calculated. We investigated two forces that might affect the motion of this N-terminus mass (tentatively identified as the blocking or inactivation particle): the magnetic field effects due to potassium ion current in the channel, and an electric force due to the decreasing density of potassium ions from the intracellular region. Time-of-flight calculations were calculated for the inactivation particle. These times will be discussed in terms of typical inactivation processes.